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"The maiden hair tree." The American publisher is G. P. PUTNAM'S SONS of New York.—J. M. C.

North American Flora.[7]—Vol. VII, part 3, continues the treatment of the Uredinales and contains the Aecidiaceae from *Prospodium* to *Dichaeoma* by JOSEPH CHARLES ARTHUR, the text for the genus *Gymnosporangium* being contributed by FRANK DUNN KERN. One new genus (*Argomyces*) is proposed, which has a geographical distribution from New Mexico and Texas through Mexico and the West Indies to South America, and is represented at present by four known species. Further new species are characterized in the following genera: *Earlea* (1), *Kuehneola* (1), *Spirechina* (1), and *Xenodochus* (1).—J. M. GREENMAN.

NOTES FOR STUDENTS

Variation curves.—Several years ago papers dealing with variation in the number of parts of flowers, flower heads, inflorescences, etc., were of frequent appearance. As the novelty of the method disappeared, the number of contributors to the knowledge of such variations has decreased, but, as is usually true in such cases, the value of the contributions has correspondingly improved. Several recent studies in this field are of exceptional interest.

VOGLER[8] gives a large number of counts of ray flowers in *Chrysanthemum*, *Boltonia*, and *Senecio*. In *Chrysanthemum Parthenium* he found a curve having the mode on 21 when the plants were grown on well-manured soil, and on 13 when grown on infertile soil, the curves being strongly skew in each case toward an intermediate point, the mean values lying between 14 and 19. These results agree essentially, therefore, with those of KLEBS[9] on *Sedum spectabile*. In *Boltonia latisquama* the ray flowers have a wide range of variation (39–81), with the summit of the curve near 55. Three different plants were separately counted in three successive years, and although the different seasons differed considerably, there was no corresponding change in the number of ray flowers. One of these plants had each year the mean number approximately 57, another approximately 54. These permanent differences are probably not to be attributed to genotypic differences in the plants, however, as they originated from a common stock by vegetative division. In *Senecio alpinus* a count of over 3000 heads from two different localities in three different years gave in every case a nearly monomodal curve with the mode on 19, thus convincing the author of the limitations of Ludwig's law that the maxima of such variation curves fall upon the numbers of the Fibonacci series, 2, 3, 5, 8, 13, etc., and low multiples of them, or on the similarly constituted "Trientalis-series," 3, 4, 7, 11, etc., and their low multiples. The latter series was discovered by Ludwig in *Trientalis*, whence its name. Vogler[10] had found earlier that the modes in the number of umbellary rays of *Astrantia major* fall upon members of the Fibonacci series when only the primary umbels are included, but in the secondary umbels the modes are on the Trientalis series. More recently the same author[11] has reported on the number of ray flowers in *Arnica montana*, *Buphthalmum salicifolium*, *Eupatorium molle*, *Aster novi-belgii*, *Senecio erucifolius*, and *Chrysanthemum Parthenium*. Several of these species gave well-marked modes on the Fibonacci numbers, but in other collections of data from the same species the mode occurred not infrequently on some quite unrelated number. For example, in *Arnica montana* a collection from Rigi, Switzerland, in 1908, showed modes on 13, 16, and 21, while heads of the same species collected the next year at Klosters presented a well-developed mode on 11 and only a slight indication of a mode on 13. Later analysis of this case showed that the terminal heads give modes on 13 and 16, while secondary heads give modes on 11 and 14, the latter numbers bearing the same relation to the Trientalis series that the former do to the Fibonacci series. This whole problem as to the position of the modes in variation curves of ray flowers, and other organs which are related more or less definitely to the phyllotactic spiral, is still unsolved, though it is evident that the Fibonacci series supplies the modal numbers in many cases, and that other equally definite series are followed in other cases. It is very rare that the number of variates used by investigators is sufficiently great to establish with any considerable degree of probable correctness these relatively superficial features of the curves. Ritter has gone to the length of asserting that non-phyllotactic variates among plant organs have their modal numbers also related to the Fibonacci or Trientalis series. He even contends that this is true of graduated variates. In support of this view he tabulates[12] a rather meager series of measurements of width and length of leaves and leaflets of *Stellaria media*, *Oxalis Acetosella*, *Lysimachia nummularia*, *Hypericum perforatum*, *Caragana arborescens*, *Rosa canina*, *Medicago sativa*, *Symphoricarpus racemosus*, *Fragaria vesca*, and *Cytisus Laburnum*, and the width and length of fruits of *Alnus glandulosa*, *Rosa canina*, *Quercus Robur*, and *Q. sessiliflora*. He believes that the measurements of surfaces, such as leaf blades, give modes related to the square roots of the Fibonacci numbers, namely, on $10\sqrt{1}$, $10\sqrt{2}$, $10\sqrt{3}$, $10\sqrt{5}$, $10\sqrt{8}$, etc., and that in tri-dimensional material such as fruits, the modes are related in similar manner to the cube roots of the Fibonacci numbers. The absurdity of such a view will be obvious when it is considered that nature takes no note of such arbitrary units of measure as the millimeter and centimeter, and that the choice of any other unit of measure would place the modes on other values. VOGLER[13] shows by a much more extensive series of measurements of leaflets of *Cytisus Laburnum* that while the curves are multimodal, the modes can not by any sort of manipulation be made to fit the Fibonacci series.

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[7] North American flora. Vol. VII, part 3, pp. 161–268. The New York Botanical Garden. April 15, 1912.

[8] VOGLER, P., Variation der Anzahl der Strahlblüten bei einigen Kompositen. Beih. Bot. Centralbl. **25**:387–396. 1910.

[9] KLEBS, G., Studien über Variation. Arch. Entwick.-Mech. Organ. **24**:29–113. 1907.

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[10] Vogler, P., Variationstatistische Untersuchungen an den Dolden von *Astrantia major*. Beih. Bot. Centralbl. **24**: 1–9. *figs. 6.* 1908.

[11] Vogler, P., Neue variationstatistische Untersuchungen an Compositen. Jahrb. St. Gallischen Naturwis. Gesells. 1910: 1–32. 1911.

[12] Ritter, G., Über discontinuirliche Variation im Organismenreiche. Beih. Bot. Centralbl. **25**: 1–29. 1909.

In another paper, VOGLER[14] performs an important service by summarizing the statistical studies which have been made upon the heads of Compositae and the umbel rays of the Umbelliferae, together with a few of the more important investigations upon the flowers and inflorescences of other species. The list of Compositae includes 45 species and of the Umbelliferae 10 species. The list gives not only the names of the species and the particular organs studied, but also states the number of counts upon which conclusions regarding the several species have been based, the apparent modes, and references to papers in the appended bibliography in which the results are recorded. This bibliography contains 63 titles.

DE BRUYKER[15] makes an extensive study of variation in the umbels of *Primula* the motive for presenting a discussion of the entire subject of statistical variation. This simple and concise presentation of the subject should occupy for Dutch readers a place similar to that held by JOHANNSEN'S[16] discussion for readers of German. It is not necessary here to consider the general treatment of the subject of variation as given by DE BRUYKER, but only the new results relating to *Primula officinalis*, *P. farinosa*, and *P. elatior*. The modal numbers of flowers in the inflorescences of these three species fall with considerable regularity upon the numbers of the Fibonacci series, but collections taken at different parts of the season show a gradual decrease in the average number of flowers per inflorescence as the season progresses. Plants growing in a favorable environment had the mode on 5, and in less favorable ones on 3. The similarity of results in collections from good and bad surroundings, and in early and later parts of the season, convinces the author of the correctness of the interpretation of the gradual fall in mean number of parts during the season, which attributes it to a change of nutrition, an interpretation which was given independently by MACLEOD and the reviewer about ten years ago. The polymorphism shown by the multimodal curves is interpreted by DE BRUYKER as due to differences in nutrition acting in conjunction with a discontinuous mode of development, through which the new organs tend to be added in groups instead of singly. The same explanation or one essentially similar is applicable to other multimodal variation curves, the series of modes being determined by the manner in which each succeeding group of organs added is related to the preceding group or groups.

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[13] VOGLER, P., Die Variation der Blattspreite bei *Cytisus Laburnum* L. Beih. Bot. Centralbl. **27**:391–437. *figs. 12.* 1911.

[14] VOLGER, P., Probleme und Resultate variationstatistischer Untersuchungen an Blüten und Blütenständen. Jahrb. St. Gallischen Naturwis. Gesells. 1910:33–71. 1911.

[15] DE BRUYKER, C., De statistische methode in de plantkunde en hare toepassingen op de studie van den invloed der levensvoorwarden. pp. 226. *figs. 33.* Gent: A. Siffer. 1910.

[16] JOHANNSEN. W., Elemente der exakten Erblichkeitslehre. pp. vi+516. *figs. 31.* Jena: Gustav Fischer. 1909.

DE BRUYKER recognizes nine series of modes for multimodal variation curves. These are as follows: (*a*) the powers of 2 (2, 4, 8, 16, etc.), as in the peristome teeth of mosses; (*b*) multiples of 3 (3, 6, 9, 12, etc.), as number of flowers in *Lonicera caprifolium;* (*c*) multiples of 4 (4, 8, 12, 16, etc.), as in the number of flowers per umbel in *Cornus Mas;* (*d*) multiples of 5 (5, 10, 15, 20, etc.), as in the number of stamens in *Pyrus communis;* (*e*) the Fibonacci-Ludwig series (1, 2, 3, 5, 8, [10], 13, [16], etc.), as in many Compositae, Umbelliferae, etc.; (*f*) the Trientalis series (1, 3, 4, 7, 11, 18, etc.), as in *Trientalis*, secondary umbels of *Astrantia major*, lateral heads of *Arnica*, etc.; (*g*) Cardamine series (2, 5, 8, 11, 13, 16, 19, 22), as found by VOGLER for the number of flowers in *Cardamine pratensis;* (*h*) the odd series (1, 3, 5, 7, 9, etc.), as in number of leaflets in imparipinnate leaves, etc.; (*i*) the even series (2, 4, 6, 8, etc.), as in paripinnate leaves, rows of grains on ears of maize, etc.

By selecting for higher number of rays in *Calliopsis bicolor*, under conditions of high nourishment, DE BRUYKER was able to secure a strain of this species, by far the largest number of whose heads had 13 rays, though the material with which he began selecting gave a very high percentage with only 8 rays. This result corresponds with that of DEVRIES with *Chrysanthemum segetum*. The sensitive period for the influence of nourishment on the number of ray flowers was investigated in *Chrysanthemum carinatum*, and this period was observed to close four or five weeks before the opening of the heads. DE BRUYKER'S work closes with a succinct statement of the principal results of the author's investigations on *Primula elatior*, *Chrysanthemum carinatum*, *C. segetum*, *Calliopsis bicolor*, *Scabiosa atropurpurea percapita*, rye, barley, and wheat. The bibliography contains references to a few more than 100 papers dealing with the subject of variation and its statistical study, and a full index is added.

NIEUWENHUIS[17] has studied the changes in the variations and in the mean values of the number of ray flowers in nine species of Compositae from the beginning to the end of the flowering season. He finds in seven of these species an essential agreement with the behavior found by the reviewer[18] in *Aster*

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[17] NIEUWENHUIS, M., Die Periodicität in der Ausbildung der Strahlblüten bei den Kompositen. Recueil Trav. Bot. Néerl. **8:**108–181. *figs. 23.* 1911.

[18] SHULL, G. H., Place-constants for *Aster prenanthoides*. BOT. GAZ. **38:**333–375. 1904.

prenanthoides. The characteristic periodicity curve of mean values in these species rises quickly to a maximum in the early part of the season, after which there is a much more gradual decline until the end of the season. Only in *Melampodium divaricatum* and in *Cosmos sulfureus* was there no essential change throughout the season, the former species having a single mode on 10 with the mean slightly above 10 in every collection made, and the latter species presenting a similar constancy, having at all times a half-curve, falling steeply from a strong mode on 5 only to higher values. In most of these species the modes were on the Fibonacci numbers; and while the changes in mean values were gradual and continuous, the appearance of modes on intermediate numbers was relatively rare. In *Anthemis Cotula* 11 and 9 appeared as transition modes between 13 and 8; 9 also appeared momentarily in *Zinnia Haageana, Z. tenuiflora,* and *Laya platyglossa;* and 11 and 12 in *Sanvitalia procumbens.* In three heterocarpous species, *Dimorphotheca pluvialis, Laya platyglossa,* and *Sanvitalia procumbens,* the plants grown from the two kinds of seeds produced essentially like variation curves. The same thing was true of plants grown in different years and in different environments, the modal numbers and characteristic slopes of the periodicity curves remaining unchanged for the particular species, though the mean values were considerably modified.—GEO. H. SHULL.

Roots of Psaronius.—Since the removal of the great mass of the marattiaceous plants of the Paleozoic to the seed plants, more critical attention has been given to *Psaronius* as the sole evidence of the existence of the Marattiaceae at that early period. Among the structures differentiating *Psaronius* from modern Marattiaceae, the most striking is the difference in the location of the secondary roots in relation to the stem. In the modern representatives of the family these roots bore their way for a considerable distance through the cortex of the stem before they penetrate to the surface. At all points in their course they are sharply marked off from the cortex by remnants of broken-down cells. In *Psaronius* they form a wide zone in the cortex of the stem in which there are no remnants of leaf traces or leaf scars, and no sharp distinction between the root cortex and the parenchyma in the interstices between the roots. STENZEL'S explanation of this root layer as homologous with the outer cortex of the Marattiaceae has passed current without question until the last ten years. In 1902 FARMER and HILL suggested that the parenchyma in the interstices of the roots of *Psaronius* might be of the nature of hairy outgrowths rather than cortical parenchyma of the stem.

The question thus raised has been attacked by SOLMS-LAUBACH[19] with convincing results. He worked cheifly with thin sections of fossils (*P. Haidingeri*) from Manebach, supplemented by material from the Museum of Rio

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[19] SOLMS-LAUBACH, H. GRAFEN ZU, Der tiefschwarze *Psaronius Haidingeri* von Manebach in Thüringen. Zeitschr. Bot. **3**:721–757. *figs 7.* 1911.